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Ocean University of China



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Ocean Monitoring and Inspection Center

Monitoring (Inspection) Report

OUC (Testing) No. HDJC2013-001

Client: Qingdao Headway Technology Co., Ltd.

Project Name: Scaling Test of OceanGuard™ Ballast Water

Management System

Inspection Dept.: Marine Chemistry Analysis and Detection Laboratory

Approved by: 宋文

Date of issue: 12/03/2013

Inspected by.: Ocean Monitoring and Inspection Center,

Ocean University of China



STATEMENT

1. The report is invalid without the official seal of Ocean Monitoring and Inspection Center, Ocean University of China (hereinafter referred to as the Center).
2. Copy of the report is invalid without the original seal of the Center.
3. The report is invalid without signature of test operator, verifier, and authorizer.
4. The report is invalid with any alteration.
5. Should any dissidence arisen on the Test Report, please contact the Center within thirty days after receiving the report. An overdue submission of any complains will be disregarded.
6. If the samples were sent to the Center by the client, the Center is only responsible for the testing results, but not for the source of the samples,.
7. Test results are valid only for the same batch of samples.
8. Copy of test reports is not allowed without written permission of the Center.
9. This report is in decuplicate, with five for English version and five for Chinese version. For each version, two original copies and one duplicate will be sent to the Client, two duplicates will be kept at the Center and the inspection department (laboratory) respectively for documentation.

To improve our testing capability and service quality continuously and to better serve clients and the community, comments from all sectors of the community to the Center are warmly welcome.

Ocean Monitoring and Inspection Center

Ocean University of China

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Name of project	Scaling Testing of OceanGuard™ Ballast Water Management System			
Client	Name: Qingdao Headway Technology Co., Ltd. Add: F4, #5 Building, Huite Industrial City, Zhuzhou Road, Qingdao, China Tel: (+86) -532-88702808			
Project Description	Entrusted by Qingdao Headway Technology Co., Ltd., the project comprises tests on physical, chemical and biological parameters and gas concentration of ballast water treated by OceanGuard™ Ballast Water Management System, in the test facility, Qingdao Beihai Shipbuilding Heavy Industry Co., Ltd. There are three types of Ballast Water Management Systems tested in this project (HMT-50, HMT-1200, HMT-3000). Ocean Monitoring and Inspection Center, Ocean University of China acts as the implementation party of the project, and accredited staffs from the Center were appointed to the test sites to supervise the operation of the whole process and to carry out sampling and on-site inspection as required. Off-site testing samples were delivered to specified laboratories of the Center and tested by accredited staffs within a specified period. The fourth cycle was completed from Feb 22 nd to Feb 27 th , 2013. The operation, sampling and inspection procedures were under supervision of CCS and DNV.			
Test Equipment	No.	Name	Model	Main Parameter
	1	Ballast Pump	Outsourcing	Rated Capacity: 50 m ³ /h, 100 m ³ /h, 1000 m ³ /h and 2200 m ³ /h
	2	Filter	HMT-50F	Rated Capacity: 50 m ³ /h
			HMT-1200F	Rated Capacity: 1200 m ³ /h
			HMT-3000F	Rated Capacity: 3000 m ³ /h
	3	EUT Unit	HMT-50E	Rated Capacity: 50 m ³ /h
			HMT-1200E	Rated Capacity: 1200 m ³ /h
			HMT-3000E	Rated Capacity: 3000 m ³ /h
	4	Flow Meter	HMT-125FM	DN125
			HMT-600FM	DN600
	5	Neutralization Unit	HMT-600N	Volume: 600L
	6	Monitoring Unit	HMT-TRO	_____
	7	Power Distribution Unit	HMT-PDU	_____
	8	Control Unit	HMT-CL	_____
Test Process and Equipment	See report page 10-15			

Test Operator:

韩秀荣

Verifier:

张陆生

Authorizer:

唐光国

Date: 11/03/2013

Date: 11/03/2013

Date: 11/03/2013

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Sampling and Storage	No.	Item	Sample Container	Collected Volume	Preservat ion	Expected Storage Time
	1	Temperature	Plastic Bottle	1 L	Test on site	—
	2	Salinity			Test on site	—
	3	TRO	Pretreated Plastic Bottle	1 L	Test on site	—
	4	DOC	Pretreated Plastic Bottle	1 L	0-4 °C	≤7d
	5	POC	Pretreated Plastic Bottle	1 L	0-4 °C	≤7d
	6	TSS	Pretreated Plastic Bottle	1 L	0-4 °C	≤24h
	7	Organisms≥50 μm	Sterile Plastic Bottle	1 m ³	Test on site	≤6h
	8	Organisms≥ (10-50)μm	Sterile Plastic Bottle	1 L	4 °C	≤24h
	9	Heterotrophic Bacteria	Sterile Plastic Bottle	1 L	4 °C	≤24h
	10	E. coli				
	11	Vibrio Cholera				
	12	Enterococcus Group Bacteria				
	13	H ₂	—	—	Test on site	—
Remark						

Test Operator: 韩秀荣

Verifier: 孙陈旭

Authorizer: 李长国

Date: 11/03/2013

Date: 11/03/2013

Date: 11/03/2013

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Testing Method and Major Instrument	No.	Item	Method	Major Instrument
	1	Temperature	Sensor Detection	VICTOR TP01
	2	Salinity	Sensor Detection	HOTEC SC-106
	3	TRO	DPD	HACH DR/2800
	4	DOC	Catalytic Combustion	SHIMADZU TOC-V _{cpn}
	5	POC	Catalytic Combustion	SHIMADZU TOC-V _{cpn}
	6	TSS	Weighting	DDG-9203 Electric Blast Drying Oven METTLER TOLEDO EL104 Balance
	7	Organisms $\geq 50\mu\text{m}$	Microscope Determination	OPTEC SMJ-T2 Stereo Microscope
	8	Organisms $\geq (10-50)\mu\text{m}$	CFDA	Leica OMLA Fluorescence Microscope
	9	Heterotrophic Bacteria	Plate Counting	YUE FENG SPX-150 Low-temperature Incubator
	10	E. coli	Counting after membrane filtration	YUE FENG SPX-150 Low-temperature Incubator
	11	Enterococcus Group Bacteria	Counting after membrane filtration	YUE FENG SPX-150 Low-temperature Incubator
	12	Vibrio Cholera	Counting after membrane filtration	YUE FENG SPX-150 Low-temperature Incubator
	13	H ₂	Sensor Detection	HAN WEI BX618 Gas Detector
Testing Results	See report page 4-9			
Laboratory Environment	Temperature	19.9 °C	Humidity	70 %
Remark				

Test Operator: 韩秀荣

Verifier: 孙世忠

Authorizer: 李国威

Date: 11/03/2013

Date: 11/03/2013

Date: 11/03/2013

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1 Testing result of Cycle 4

1.1 Operating Condition

Name of the system: OceanGuard™ Ballast Water Management System

Manufacturer: Qingdao Headway Technology Co., Ltd.

Location: No.8 Wharf, Qingdao Beihai Shipbuilding Heavy Industry Co., Ltd.

Cycle NO.: 4

Date: 02/22/2013—02/27/2013

Weather(Ballasting): Sunny

Longitude: 35°59.18'E

Latitude: 120°16.25'N

Water Depth: 10.2 m

Test Operator:

韩秀果

Verifier:

祝陈华

Authorizer:

李长国

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1.2 Operating Data

Table1.2.1 Operating time and flow

Date	Process Description	Start Time	Stop Time	Average Flow Rate (m ³ /h)
02/22/2013	Treated Water (HMT-50)	16:15	16:58	62.71
02/22/2013	Treated Water (HMT-1200)	14:57	15:19	1639
02/22/2013	Treated Water (HMT-3000)	14:32	14:51	3189
02/22/2013	Control Water	17:05	17:25	65.4

Table1.2.2 Monitoring Report of different TRO Detectors

Item	Salinity (PSU)	TRO (mg/L) DPD Method	TRO (mg/L) Probe Method
Treated Water (HMT-50)	19.2±0.2	2.02	1.94
Treated Water (HMT-1200)	21.1±0.1	2.02	1.95
Treated Water (HMT-3000)	21.6±0.3	2.08	2.01

Test Operator:

韩秀荣

Verifier:

陈阳

Authorizer:

李光国

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1.3 Test result of water and gas

Table1.3.1Test result of influent water²

Item	Influent Water		
	HMT-50	HMT-1200	HMT-3000
Temperature (°C)	4.1±0.1	4.9±0.3	5.0±0.2
Salinity (PSU)	19.4±0.3	21.0±0.1	21.4±0.6
TRO (mg/L)	0.01±0.01	0.01±0.01	0.00±0.00
POC (mg/L)	0.40±0.02	0.43±0.05	0.42±0.08
DOC (mg/L)	1.54±0.23	1.87±0.11	1.56±0.25
TSS (mg/L)	6.59±0.85	7.25±1.50	7.36±0.79
H ₂ (%LEL)	0.0	0.0	0.0

Table1.3.2Test result of treated water

Item	Treated Water		
	HMT-50	HMT-1200	HMT-3000
Temperature (°C)	4.4±0.1	4.9±0.1	4.9±0.2
Salinity (PSU)	19.2±0.2	21.1±0.1	21.6±0.3
TRO (mg/L)	1.99±0.03	2.00±0.10	2.06±0.03
POC (mg/L)	0.36±0.03	0.39±0.06	0.34±0.02
DOC (mg/L)	1.56±0.04	1.74±0.12	1.49±0.14
TSS (mg/L)	6.13±0.12	6.45±0.23	6.56±0.18
H ₂ (%LEL)	0.0	0.0	0.0

Test Operator:

韩秀荣

Verifier:

刘陈宝

Authorizer:

李国

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Table1.3.3 Test result of discharged water

Item	Discharged Water		
	HMT-50	HMT-1200	HMT-3000
Temperature (°C)	4.2±0.1	4.8±0.1	4.8±0.5
Salinity (PSU)	19.4±0.1	21.0±0.1	21.5±0.2
TRO (mg/L)	0.01±0.01	0.02±0.01	0.01±0.01

Table1.3.4 Test Result of control water

Item	Control Water
Temperature (°C)	4.3±0.2
Salinity (PSU)	20.2±0.1
TRO (mg/L)	0.01±0.01
POC (mg/L)	0.47±0.02
DOC (mg/L)	1.93±0.08
TSS (mg/L)	6.94±0.15
Organisms≥50μm (/m ³)	496.13±15.01
Organisms≥10-50 μm (/mL)	(1.70±0.62)×10 ²
Heterotrophic bacteria (cfu/100mL)	(4.87±4.76)×10 ⁵
E. coli (cfu/100mL)	0.67±0.58
Enterococcus group bacteria (cfu/100mL)	0.67±0.15
Vibrio cholera (cfu/100mL)	0.00±0.00
H ₂ (%LEL)	0.0

Test Operator:

韩秀荣

Verifier:

初防宣

Authorizer:

李长国

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Table1.3.5 Test result of storage tank (T1)

Item	T1 (Water Treated by HMT-50)				
	Day 1	Day 2	Day 3	Day 4	Day 5
Temperature (°C)	5.0	5.1	5.0	5.9	5.7
Salinity (PSU)	19.2	19.3	19.2	19.3	19.4
TRO (mg/L)	0.08±0.01	0.02±0.02	0.01±0.01	0.01±0.01	0.01±0.01
H ₂ (%LEL)	0.0	0.0	0.0	0.0	0.0

Table1.3.6 Test result of storage tank (T2)

Item	T2 (Water Treated by HMT-1200)				
	Day 1	Day 2	Day 3	Day 4	Day 5
Temperature (°C)	4.8	5.5	5.3	5.7	5.8
Salinity(PSU)	21.3	21.1	21.2	21.1	21.2
TRO (mg/L)	0.09±0.01	0.04±0.01	0.01±0.01	0.01±0.01	0.01±0.01
H ₂ (%LEL)	0.0	0.0	0.0	0.0	0.0

Table1.3.7 Test result of storage tank (T3)

Item	T3 (Water Treated by HMT-3000)				
	Day 1	Day 2	Day 3	Day 4	Day 5
Temperature (°C)	4.4	5.6	5.2	5.9	6.0
Salinity (PSU)	21.6	21.5	21.6	21.6	21.5
TRO (mg/L)	0.06±0.01	0.01±0.01	0.01±0.01	0.01±0.01	0.00±0.00
H ₂ (%LEL)	0.0	0.0	0.0	0.0	0.0

Test Operator:

韩秀荣

Verifier:

祝陈华

Authorizer:

李光国

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Table1.3.8 Test result of storage tank (T4)

Item	T4 (Control Water)				
	Day 1	Day 2	Day 3	Day 4	Day 5
Temperature (°C)	4.6	5.5	5.2	5.9	5.8
Salinity (PSU)	20.3	20.2	20.2	20.1	20.3
TRO (mg/L)	0.01±0.01	0.00±0.00	0.01±0.01	0.02±0.01	0.00±0.00
H ₂ (%LEL)	0.0	0.0	0.0	0.0	0.0

Table1.3.9 TRO Concentration at Different Salinity (Test on site)

Item	Salinity (PSU)	TRO (mg/L)
Treated Water (HMT-50)	3.2	2.02
Treated Water (HMT-50)	2.0	2.05
Treated Water (HMT-50)	1.1	1.95

Test Operator:

韩秀荣

Verifier:

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2 Test Introduction

It is the scaling testing of brackish water, and a barge is loaded with fresh water at the wharf in advance. While operating, fresh water pumped from the barge by fresh water ballast pump mixes with the sea water pumped by the sea water ballast pump in the pipe, then both run through OceanGuard™ Ballast Water Management System. The treated water goes into the sea after neutralization process of the Neutralization Unit.

A full scaling testing cycle includes ballasting and storage. Three types of OceanGuard™ Ballast Water Management System in this project (with the rated capacity of 50m³/h, 1200 m³/h and 3000 m³/h).

According to QAPP, the salinity was controlled between 18 PSU to 23 PSU, and TRO concentration testing in lower salinity was added.



Picture 2.1 Barge loaded with fresh water

Test Operator: 韩秀荣

Verifier: 孙传宝

Authorizer: 李长国

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An example of running HMT-3000 system was given. Firstly, after starting the P3 and P4 Pump, water go through the Filter (HMT-3000F), as well as the EUT Unit (HMT-3000E) for treatment. Treated water goes into the sea after neutralization process of the Neutralization Unit (HMT-600N). During the treatment process, 1m^3 of treated water goes into the storage tank T3. Operating process of HMT-50 and HMT-1200 is exactly the same as that of HMT-3000. The last step is simulating ballasting process of control water, i.e., water is pumped through the pump by the bypass pipe and then goes into the sea directly. During the process, 1m^3 of control water goes into storage tank T4. After ballasting, all the storage tanks will be covered with opaque cover to avoid sunlight. There are 3 sampling points in the pipes of each system, for the sampling of influent water, treated water and discharged water.

Water in storage tanks T1、T2、T3、T4 should by stored for 5 days. TRO concentration, temperature, salinity and concentration of hydrogen gas in the top of the tank should be measured every day during the 5 days' period.

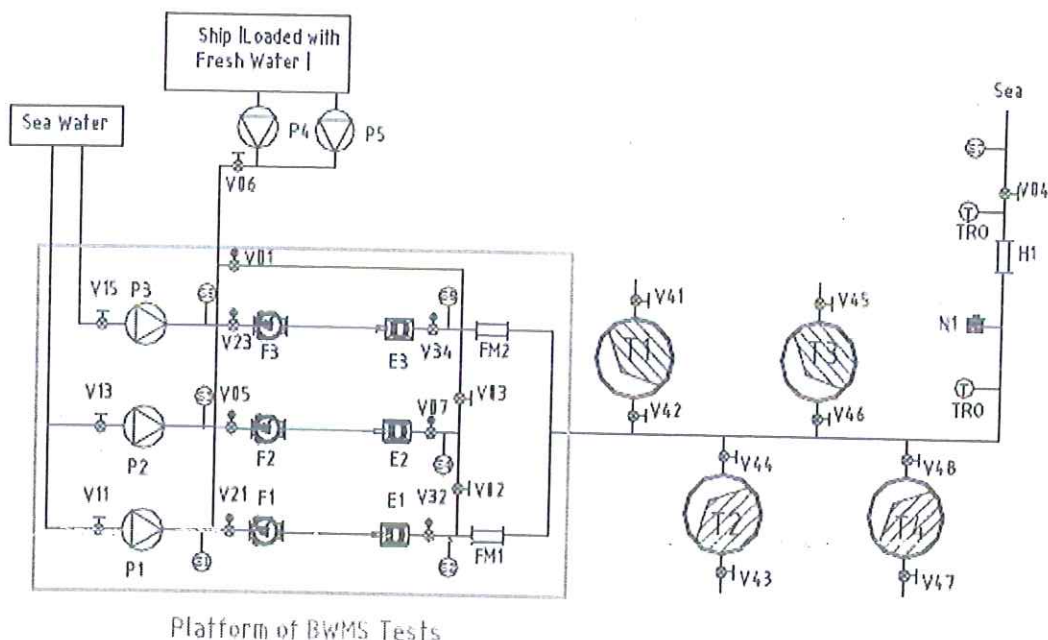


Figure 2.1 System layout of scaling test

Test Operator:

韩秀荣

Verifier:

孙防

Authorizer:

李光国

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Table 2.1 Notation for the system layout of scaling test

No.	Name	Main Parameters	Model
P1	Ballast Pump	Rated Capacity: 100 m ³ /h	—
P2	Ballast Pump	Rated Capacity: 2200 m ³ /h	—
P3	Ballast Pump	Rated Capacity: 2200 m ³ /h	—
P4	Ballast Pump	Rated Capacity: 1000 m ³ /h	—
P5	Ballast Pump	Rated Capacity: 50 m ³ /h	—
F1	Filter	Rated Capacity: 50 m ³ /h	HMT-50F
F2	Filter	Rated Capacity: 1200 m ³ /h	HMT-1200F
F3	Filter	Rated Capacity: 3000 m ³ /h	HMT-3000F
E1	EUT Unit	Rated Capacity: 50 m ³ /h	HMT-50E
E2	EUT Unit	Rated Capacity: 1200 m ³ /h	HMT-1200E
E3	EUT Unit	Rated Capacity: 3000 m ³ /h	HMT-3000E
FM1	Flow Meter	DN125	HMT-125FM
FM2	Flow Meter	DN600	HMT-600FM
N1	Neutralization Unit	Volume: 600L	HMT-600N
H1	Static Mixers	DN600	—
T1-T4	Tank	Volume: 1m ³	—
V01-V48	Valve	—	—

Test Operator:

韩大荣

Verifier:

张陆忠

Authorizer:

李国

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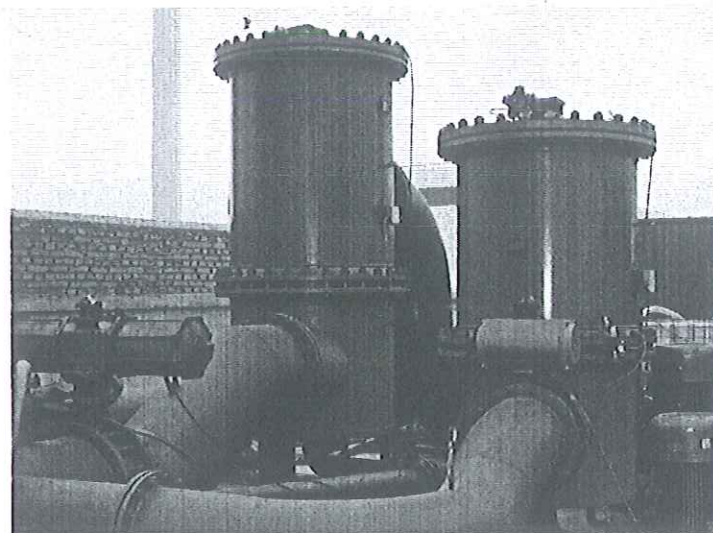
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3 Pictures of system tested



Picture 3.1 Filter



Picture 3.2 EUT Unit

Test Operator: 韩秀荣

Verifier: 孙防宝

Authorizer: 李国

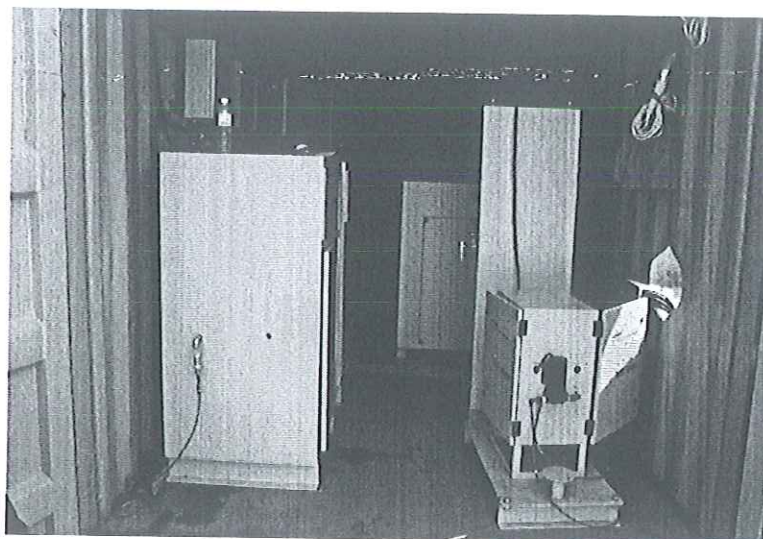
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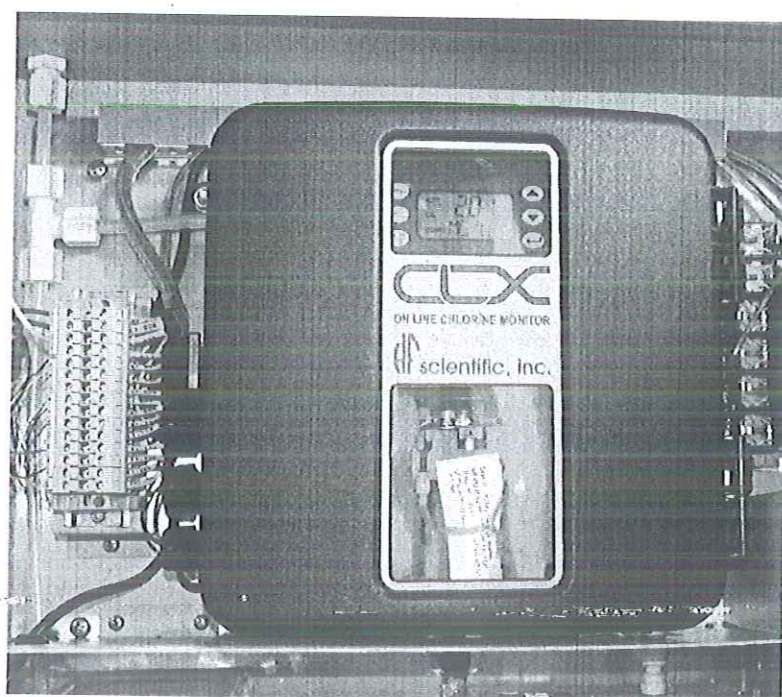
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Picture 3.3 Equipment layout of scaling test



Picture 3.4 TRO Meter with DPD Method

Test Operator: 韩秀荣

Verifier: 孙陈宝

Authorizer: 李光国

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Picture 3.5 Operation of the system

Test Operator: 韩秀芳

Verifier: 孙世宁

Authorizer: 李国

Checklist of Scaling Test of OceanGuard™ Ballast Water Management System

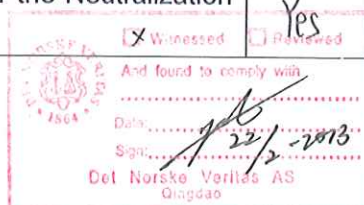
Checklist number: HMT-BWMS-ST-CN-04

Manufacturer: Qingdao Headway Technology Co., Ltd.

Place: 8 Wharf, Qingdao Beihai Shipbuilding Heavy Industry Co., Ltd.

Date: Feb., 22nd, 2013, Friday

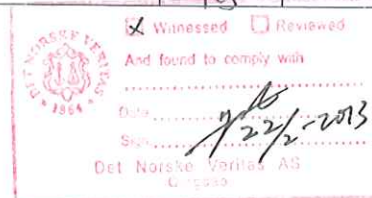
No.	To be checked	Yes/No	Mark
1	Installation of equipment		
1.1	OceanGuard™ BWMS of 50 m³/h		
1.1.1	Components of the System: Filter, EUT Unit, Control Unit, Power Distribution Unit, EUT Power Unit, Neutralization Unit, Monitoring Unit, Flow Meter	Yes	
1.1.2	System piping arrangement is consistent with QAPP (please refer to P4 in QAPP for details)	Yes	
1.1.3	Sampling point of influent water is before the Filter	Yes	
1.1.4	Sampling point of treated water is after the EUT Unit.	Yes	
1.1.5	Sampling point of discharging water is after the Neutralization Unit.	Yes	
1.1.6	A simulated ballast tank of 1m³ is near the system for storage of treated water.	Yes	
1.2	OceanGuard™ BWMS of 1200 m³/h		
1.2.1	Components of the System: Filter, EUT Unit, Control Unit, Power Distribution Unit, EUT Power Unit, Neutralization Unit, Monitoring Unit, Flow Meter	Yes	
1.2.2	System piping arrangement is consistent with QAPP (please refer to P4 in QAPP for details)	Yes	
1.2.3	Sampling point of influent water is before the Filter	Yes	
1.2.4	Sampling point of treated water is after the EUT Unit.	Yes	
1.2.5	Sampling point of discharging water is after the Neutralization Unit.	Yes	
1.2.6	A simulated ballast tank of 1m³ is near the system for storage of treated water.	Yes	
1.3	OceanGuard™ BWMS of 3000 m³/h		
1.3.1	Components of the System: Filter, EUT Unit, Control Unit, Power Distribution Unit, EUT Power Unit, Neutralization Unit, Monitoring Unit, Flow Meter	Yes	
1.3.2	System piping arrangement is consistent with QAPP (please refer to P4 in QAPP for details)	Yes	
1.3.3	Sampling point of influent water is before the Filter	Yes	
1.3.4	Sampling point of treated water is after the EUT Unit	Yes	
1.3.5	Sampling point of discharging water is after the Neutralization Unit	Yes	



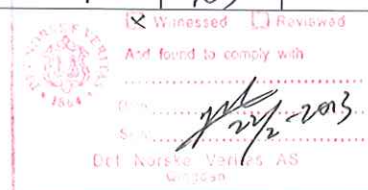
1.3.6	A simulated ballast tank of 1m ³ is near the system for storage of treated water	Yes	
1.4	Bypass		
1.4.1	Open and close state of the bypass pipe is controlled by automatic valve	Yes	
1.4.2	There is a sampling point in the bypass	Yes	
1.4.3	A simulated ballast tank of 1m ³ is near the system for storage of treated water	Yes	
2	Operation of equipment		
2.1	OceanGuard™ BWMS of 50 m³/h		
2.1.1	Press the key "Ballast on", automatic valves are open or closed in normal state	Yes	
2.1.2	There is normal display in the panel of control unit	Yes	
2.1.3	Flow rate is around 50 m ³ /h	Yes	56 m ³ /h
2.1.4	There is display of TRO concentration after the EUT unit, and the value is equal to 2 mg/L	Yes	20 PSU 3 PSU 2 PSU 1 PSU
2.1.5	When the Neutralization Unit starts work, neutralizer is added into the pipe	Yes	201 mg/L 202 mg/L 205 mg/L 195 mg/L
2.1.6	TRO concentration after the neutralization unit is lower than 0.2 mg/L	Yes	0.00 mg/L
2.1.7	Press the key "Ballast off", the automatic valve works in normal state	Yes	
2.1.8	There is record in the Log of Control Unit, and the time recorded as well as contents are correct	Yes	
2.1.9	During operation, 1 m ³ of water goes into simulated ballast tank	Yes	
2.2	OceanGuard™ BWMS of 1200 m³/h		
2.2.1	Press the key "Ballast on", automatic valves are open or closed in normal state	Yes	
2.2.2	There is normal display in the panel of control unit	Yes	
2.2.3	Flow rate is around 1200 m ³ /h	Yes	1637 m ³ /h
2.2.4	There is display of TRO concentration after the EUT unit, and the value is equal to 2 mg/L	Yes	1.99 mg/L
2.2.5	When the Neutralization Unit starts work, neutralizer is added into the pipe	Yes	
2.2.6	TRO concentration after the neutralization unit is lower than 0.2 mg/L	Yes	0.00 mg/L
2.2.7	Press the key "Ballast off", the automatic valve works in normal state	Yes	
2.2.8	There is record in the Log of Control Unit, and the time recorded as well as contents are correct	Yes	
2.2.9	During operation, 1 m ³ of water goes into simulated ballast tank	Yes	

☒ Witnessed ☐ Reviewed
 And found to comply with
 Date: 4/22/2013
 Sign: [Signature]
 Det. Noriko Veritas AS
 Legation

2.3	OceanGuard™ BWMS of 3000 m³/h		
2.3.1	Press the key "Ballast on", automatic valves are open or closed in normal state	Yes	
2.3.2	There is normal display in the panel of control unit	Yes	
2.3.3	Flow rate is around 3000 m³/h	Yes	3135 m³/h
2.3.4	There is display of TRO concentration after the EUT unit, and the value is equal to 2 mg/L	Yes	201 mg/L
2.3.5	When the Neutralization Unit starts work, neutralizer is added into the pipe	Yes	
2.3.6	TRO concentration after the neutralization unit is lower than 0.2 mg/L	Yes	0.02 mg/L
2.3.7	Press the key "Ballast off", the automatic valve works in normal state	Yes	
2.3.8	There is record in the Log of Control Unit, and the time recorded as well as contents are correct	Yes	
2.3.9	During operation, 1 m³ of water goes into simulated ballast tank	Yes	
2.4	Operation of bypass		
2.4.1	Press the key of "Emergency On" in control unit, valve of the bypass is opened automatically, and other valves are closed	Yes	
2.4.2	Sound and light alarm is started	Yes	
2.4.3	Press the key of "Mute", and the sound alarm is canceled	Yes	
2.4.4	Press the key of "Emergency Off" in control unit, valve of the bypass is closed automatically	Yes	
2.4.5	During operation, 1 m³ of water goes into simulated ballast tank	Yes	
3	Sampling, Storage and Transportation		
3.1	OceanGuard™ BWMS of 50 m³/h		
3.1.1	Sampling bottles are numbered regularly, labels are waterproof and stuck firmly	Yes	
3.1.2	Sampling of influent water: three parallel samples for each parameter at three different time respectively	Yes	
3.1.3	Three parameters of influent water sampling are included: temperature and salinity, TSS, DOC and POC	Yes	
3.1.4	Sampling of treated water: three parallel samples for each parameter at three different time respectively	Yes	
3.1.5	One parameter of treated water sampling is included: TRO	Yes	
3.1.6	Sampling of discharging water: three parallel samples for each parameter at three different time respectively	Yes	
3.1.7	One parameter of discharging water sampling is included: TRO	Yes	
3.1.8	Samples that need to be tested in the lab, should be put into the thermal insulation box of ≤4°C immediately after sampling	Yes	
3.1.9	Samples in the thermal insulation box should be delivered to	Yes	



	the lab within 6 hours		
3.1.10	Monitor concentration of hydrogen gas in simulated ballast tanks	Yes	
3.2	OceanGuard™ BWMS of 1200 m³/h		
3.2.1	Sampling bottles are numbered regularly, labels are waterproof and stuck firmly	Yes	
3.2.2	Sampling of influent water: three parallel samples for each parameter at three different time respectively	Yes	
3.2.3	Three parameters of influent water sampling are included: temperature and salinity, TSS, DOC and POC	Yes	
3.2.4	Sampling of treated water: three parallel samples for each parameter at three different time respectively	Yes	
3.2.5	One parameter of treated water sampling is included: TRO	Yes	
3.2.6	Sampling of discharging water: three parallel samples for each parameter at three different time respectively	Yes	
3.2.7	One parameter of discharging water sampling is included: TRO	Yes	
3.2.8	Samples that need to be tested in the lab, should be put into the thermal insulation box of ≤4°C immediately after sampling	Yes	
3.2.9	Samples in the thermal insulation box should be delivered to the lab within 6 hours	Yes	
3.2.10	Monitor concentration of hydrogen gas in simulated ballast tanks	Yes	
3.3	OceanGuard™ BWMS of 3000 m³/h		
3.3.1	Sampling bottles are numbered regularly, labels are waterproof and stuck firmly	Yes	
3.3.2	Sampling of influent water: three parallel samples for each parameter at three different time respectively	Yes	
3.3.3	Three parameters of influent water sampling are included: temperature and salinity, TSS, DOC and POC	Yes	
3.3.4	Sampling of treated water: three parallel samples for each parameter at three different time respectively	Yes	
3.3.5	One parameter of treated water sampling is included: TRO	Yes	
3.3.6	Sampling of discharging water: three parallel samples for each parameter at three different time respectively	Yes	
3.3.7	One parameter of discharging water sampling is included: TRO	Yes	
3.3.8	Samples that need to be tested in the lab, should be put into the thermal insulation box of ≤4°C immediately after sampling	Yes	
3.3.9	Samples in the thermal insulation box should be delivered to the lab within 6 hours	Yes	
3.3.10	Monitor concentration of hydrogen gas in simulated ballast tanks	Yes	
3.4	Sampling of control water		
3.4.1	Sampling bottles are numbered regularly, labels are waterproof	Yes	



	and stuck firmly		
3.4.2	Sampling of control water: three parallel samples for each parameter at three different time respectively	Yes	
3.4.3	Three parameters of control water sampling are included: temperature and salinity, TSS, DOC and POC, organisms $\geq 50\mu\text{m}$, organisms $\geq 10\text{-}50\mu\text{m}$ and bacteria	Yes	
3.4.4	Samples that need to be tested in the lab, should be put into the thermal insulation box of $\leq 4^{\circ}\text{C}$ immediately after sampling.	Yes	
3.4.5	Samples in the thermal insulation box should be delivered to the lab within 6 hours	Yes	
3.4.6	Monitor concentration of hydrogen gas in simulated ballast tanks	Yes	
3.5	Sampling from simulated ballast tank (during storage)		
3.5.1	Sampling bottles are numbered regularly, labels are waterproof and stuck firmly	Yes	
3.5.2	One sample for one parameter from each simulated ballast tank is taken	Yes	
3.5.3	One parameter of sampling is included: TRO, temperature and salinity	Yes	
3.5.4	Monitor concentration of hydrogen gas in simulated ballast tanks	Yes	
4	On-site check		
4.1	All testing equipments have been calibrated with calibration label	Yes	
4.2	Three parameters are tested on-site: temperature, salinity, TRO	Yes	
4.3	Sensor thermometer is used to measure temperature	Yes	
4.4	Salinity meter of sensor type is used to measure temperature	Yes	
4.5	2800 spectrophotometer is used to monitor concentration of TRO	Yes	
4.6	Gas detector of sensor type is used to monitor concentration of hydrogen gas	Yes	
5	Check the data		
5.1	Concentration of hydrogen gas in all test cycles is below 4%	Yes	
5.2	TRO concentration of treated water is equal to 2 mg/L	Yes	
5.3	TRO concentration of discharging water is lower than 0.2 mg/L	Yes	

